Engineering Standard
Electrical

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TRANSFORMER LOSS EVALUATION

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Engineering Standard

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Document control

Version	Date	Summary of change
	November 2001	Last Technical Review
3.0	May 2010	• Application of TMA 400 format
3.1	Aug 2012	• Section 1 – Introduction has been modified • New Section 4 – Cost of Energy has been added • The title for Section 5 has been changed

Contents

1 Introduction

This standard details the parameters to be used when evaluating tenders for the supply of transformers, to ensure that the lowest whole-of-life cost transformer is obtained. It also details the process when the losses verified by testing exceed the manufactures guaranteed value.

2 Transformer Losses

RailCorp transformers are seldom fully loaded. For the purposes of comparison of transformer losses for Tender evaluation the following values are to be used:

415V, 240V, 120V Tx	100% No Load losses x 8760 hours 80% Full Load losses x 8760 hours
33/11, 66/11, 66/33 etc. energised all the time	100% No Load losses x 8760 hours 50% Full Load losses x 8760 hours
33/11, 66/11, 66/33 etc. Energised half the time including rectifier Tx	50% No Load losses x 8760 hours 25% Full Load losses x 8760 hours

See Appendix A for derivation of the load percentages.

3 Transformer Cost Evaluation

The NPV method is used, taking into account the current costs of the annual losses only. The expression is:

$$NPV = P + \frac{A}{r} * \{1 - (1 + r)^{-N}\}$$

P = initial cost of Transformer including any spares, tests, training etc.

A = annual cost of losses

r = interest rate

N = number of years ('life' of Tx)

For the usual values of 20 years and 7%, this becomes:

*NPV = P + 10.6*A*

The method to be used to calculate the lifetime costs of transformers for tender evaluation purposes is:

a) Select the relevant no-load and load losses from above and multiply by the cost per kWh and add to get 'A' for each transformer offered.

b) Calculate from the above, using the values given for 'r' and 'N' in the Specification and the Tendered prices for transformers and any required tests etc.

c) The lowest priced, technically complying transformer is selected.

4 Cost of Energy

At the time of publication of this document, the cost of energy to Railcorp is 12 cents/kWh. The cost of energy used in the transformer cost evaluation should be certified with the RailCorp Electricity Business Manager at the time of tender.

5 Transformer Losses Verified by Testing

Transformer manufacturers provide 'guaranteed loss' figures in their tenders. If the actual tested losses exceed these guaranteed values, then the purchase price is reduced to recompense RailCorp for the additional costs which will accrue during the life of the transformer. Use the same NPV method as above to calculate these deductions but use the *difference* between actual and guaranteed cost of annual losses.

Appendix A Factors to be used for Transfomer losses

For smaller transformers, assume a constant load all day, and in year 1 it is 75% loaded, increasing to 100% loaded after 20 years. The equivalent load losses are 81% of the load losses if it was operated at rated full load continuously. Even this is more onerous than the way these transformers are usually loaded.

For these transformers use 80% of the load losses to be a bit more realistic.

Rectifier and large power transformers (33/11 etc.) have a daily load cycle which, when fully loaded in the peak hours only, causes daily load losses of about 60% of the load losses which would occur if operated at rated load all day. Also, they are not even fully loaded in the peak hours when originally installed, and we could use a long-term load growth as above. (ie. 75% increasing to 100% in 20 years)

Over the whole life, the load losses are only 0.81 x 0.6 ≈ 50% of continuous rated load losses.

Summary of Losses to be used in Transformer Cost Evaluation

415V, 240V, 120V Tx	100% No Load losses x 8760 hours 80% Full Load losses x 8760 hours
33/11, 66/11, 66/33 etc. energised all the time	100% No Load losses x 8760 hours 50% Full Load losses x 8760 hours
33/11, 66/11, 66/33 etc. Energised half the time including rectifier Tx	50% No Load losses x 8760 hours 25% Full Load losses x 8760 hours